QUANTITATIVE PRECIPITATION AND HYDROMETEOR CONTENT ESTIMATION IN TROPICAL CYCLONES FROM REMOTE SENSING OBSERVATIONS

by

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ABSTRACT

Quantitative rain rate and hydrometeor content retrievals from spaceborne remote sensing measurements in tropical cyclones over ocean and related microphysics issues are discussed in this study. An emission-based rainfall rate algorithm for the Stepped Frequency Microwave Radiometer (SFMR) on the National Oceanic and Atmospheric Administration (NOAA) hurricane research aircraft WP-3D is validated by using simultaneous observations from two radars on the same aircraft. Data collected in Hurricane Bonnie (1998) and Humberto (2001) are used in the comparisons. It is found that a coefficient in the attenuation – rain rate relationship used in the existing SFMR algorithm is incorrect. After the algorithm correction, a linear regression result with a correlation coefficient of 0.8 and a slope close to 1 is obtained between SFMR and radar derived rain rates. But an overall high bias of 5 mm/hr of the SFMR rainfall estimate relative to radar is also found, which is related to the comparison scheme. The error analysis shows that the bias is nearly independent of rain type, a result in agreement with previous results that the rain drop size distributions between convective and stratiform rain in hurricanes are similar.

A combined radar-radiometer algorithm is developed to estimate hydrometeor profiles in tropical cyclones and convection over ocean for the Tropical Rainfall Measurements Mission (TRMM). It is designed to adjust the parameters in the exponential particle size distribution (PSD) for rain, snow, and graupel iteratively by minimizing the difference between observed brightness temperatures and simulated ones.

The algorithm is first applied to the aircraft observations to evaluate the performance. A comparison of the retrieval results with aircraft *in situ* measurements, independent radiometer observations, and other retrieval algorithms indicates that the algorithm can provide reliable hydrometeor content estimates and that the radar-only retrieval is improved by including brightness temperature data into the combined algorithm. The application to the TRMM case shows that the beamfilling bias for the combined algorithm is comparable to that for the radar-only algorithm other than as large as that for the radiometer-only algorithm. The largest variability is found for the retrieval in the Hurricane Isabel (2003) eyewall convective region, indicating that the eyewall represents the most complicated condition for the remote sensing retrieval.

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